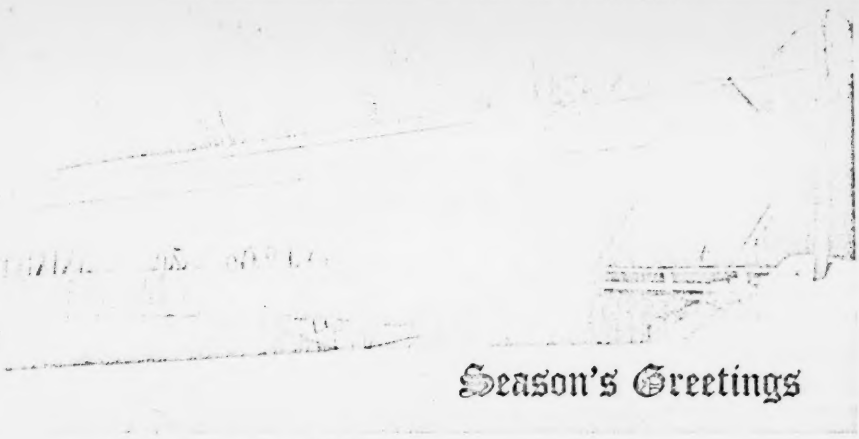
Monthly Review

Federal Reserve Bank of Boston



A Covered Bridge at Jackson, New Hampshire

ANNUAL REVIEW OF NEW ENGLAND BUSINESS:

Good Business and Basic Changes In Manufacturing Go Hand in Hand

A generally high level of business activity during 1952 provided an opportunity for New England communities to improve the diversity of their manufacturing activities. Continued slowness in the nation's textile industry during the first half of the year brought shorter working weeks and occasional mill shutdowns in New England. As a partial offset to these reverses, the metalworking industries held strong during the first quarter. Also, the construction industry held its working forces at high levels throughout the summer season. With the coming of fall, a greater flow of steel and increased orders to textile manufacturers sparked a general rise in business activity that carried through the Christmas season.

The thousands of year-end annual reports being tallied by New England businessmen will fill out a picture of important structural changes in New England's industrial economy. Manufacturers' reports will generally show increased output of "hard-good" defense materials and extensive additions to manufacturing capacity, but red ink will flow through some of the reports from textile centers. Financial companies will report the large additions to liquid savings, life insurance, and investments that New Englanders have made. Retail store reports will emphasize the steady volume of business that reduced their inventories and encouraged them to send new orders along to manufacturers. On balance, the reports will add up to a prosperous 1952 highlighted by the steel strike.

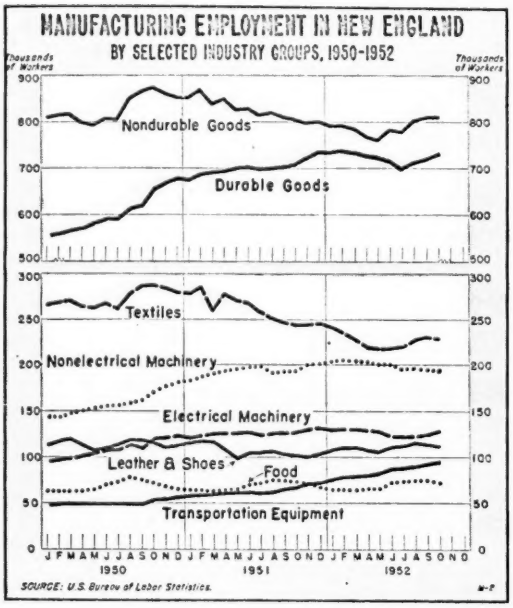
The high level of business activity greatly facilitated New England's continuing transition from textiles into durable-goods manufacturing. Throughout 1952, total manufacturing employment did not waver more than two per cent above or below the average of 1,510 thousand persons employed. Manufacturing employment in October 1952 was 1,512 thousand, about 32 thousand less than the postwar peak in February 1951. At the same time, textile employment was 57 thousand less than its February 1951 level. In contrast, the metal-using industries expanded employment by 30 thousand between the same dates.

Unemployment patterns reflected the industrial shifts. The labor markets which suffered from heavy unemployment continued to be those heavily dependent on the textile industry. Early in 1952, unemployment-insurance claims were running well above those in the comparable months of 1951. Expanding construction activity provided some extra jobs during the summer, and then a fall upturn in business reversed the comparison. In September, unemployment claims fell to a level 30 per cent below the corresponding 1951 totals.

Retail sales in New England, as analyzed in an accompanying article, showed a declining trend during the first quarter of 1952 but strengthened in the second quarter and moved generally upward through the summer and fall months. The dollar volume of department store sales for the first ten months of 1952 about equalled sales for the corresponding period of last year.

During the first half of 1952, the inventory adjustments continued. Retail inventories had been cut back sharply in 1951 and registered only slight changes in 1952. Wholesale inventories were further reduced and manufacturers maneuvered to cut back on their stocks. Improved retail sales during the fall led to heavier reordering and some inventory accumulation in advance of the Christmas season. By November new orders to manufacturers were still expanding, but at a slower rate.

Defense contracts played an active but smaller role in supporting business activity in the region. Classified contracts for research and production of secret defense



materials continued in large volume. New England's nonsecret contracts for manufactured articles totaled about $959 million by the end of September, a figure only 55 per cent as large as the 1951 value for a comparable period. Textile contractors were particularly affected. During the first three quarters of 1951, they received contracts totaling about $188 million, only 27 per cent of the 1951 contracts during the same period.

Commodity prices and consumer prices moved in opposite directions during the year. In mid-November the index of raw industrial commodities was slightly lower than in late August. It was 17 per cent below its level in mid-November 1951, mainly because of sharp declines during the first five months of 1952. In contrast, the Boston consumers' price index in October stood 1.8 per cent higher than a year ago and 10.3 per cent above the level of June 1950.

In New England, contracts awarded during the first ten months of 1952 called for more individual construction projects than in the corresponding period in 1951, according to F. W. Dodge Corporation. Valuations exceeded those of a year ago by almost 13 per cent but were affected by higher construction costs reflecting advancing wage scales.

On a ten-month basis, contracts for residential building were 25 per cent ahead of those last year, and contracts for public works were 39 per cent ahead. The valuation of nonresidential construction dropped nine per cent from its 1951 level, primarily because of a 48 per cent drop in awards for construction of manufacturing buildings.

Business lending at New England banks during 1952 reflected both a high rate of business activity and adjustment which occurred within industry groups. During the first half of the year increases in commercial loans to manufacturers of metals and metal products and to public utilities offset repayments by other industry groups and trade borrowers. Loans to food, textile, apparel and leather companies paced the usual seasonal expansion in borrowing during the fall. By December 1, the outstanding district business-loan volume exceeded the level reported last year by about five per cent. Substantial credit continued to flow to defense and defense-supporting activities, but the proportions were smaller than those last year.

Durable-Goods Industries

Defense-related durable-goods industries such as ordnance and transportation equipment expanded steadily through the year, even during the steel strike. Other steel-using industries slowed operations as steel ran out, but recovered quickly in the fall.

Activity in the **nonelectrical-machinery** industry remained at a high level during October, but in the aggregate there was little change from September or the corresponding level of a year ago. Machine-tool firms continued to expand capacity to meet defense requirements. Defense contracts continued to play a large role. During the third quarter, the industry received unclassified defense orders totaling approximately $31 million in value.

The **electrical-machinery** industry led all other branches of manufacturing in its rate of expansion during October, despite the involvement of about 900 workers in a labor dispute. Firms producing electronic tubes and components continued their steady growth, while those making heavy electrical machinery were enabled to resume full-scale operations as adequate supplies of steel became available. Seasonal demands for radios, television and Christmas-lighting equipment boosted fall orders.

New England **ordnance** plants, during October, maintained the high rate of operations attained as summer ended, but made no further gains beyond this level. Nonsecret government contracts for ordnance fell off in September and October to roughly $18 million per month, in contrast to the monthly average of $26 million which had prevailed from April to August.

New England's **primary metal** industries showed no significant changes in activity as the year neared its end. Metal shortages resulting from the steel strike seemed to be about over by the end of November. Most overdue shipments had been delivered and strip mills had some unsold capacity available for first quarter 1953. During October and November, the region's three open-hearth steel producers maintained operations just below 90 per cent of capacity, which was practically the same rate as that reported during the corresponding period of 1951.

Contrary to the general trend of prices in **iron and steel**, the Mystic Iron Works reduced its fourth-quarter price for pig iron by 50 cents a ton early in October. New England prices for cast scrap continued weak in spite of a temporary interruption in local pig-iron production. This reflected a slack situation in the foundry industry, which has experienced a lag in orders.

In the **brass** industry, activity increased in November following settlement of a work stoppage affecting several thousand workers. Reports from the industry indicate that total shipments for 1952 will be about 15 per cent lower than in 1951.

The **transportation-equipment** industry chalked

up a steady growth during the year, with gains principally at aircraft and automobile-assembly plants. Although shipbuilding plants remained very active, there were no significant changes in staffs. As the year ended, the Quincy yard was constructing more vessels of 1,000 or more tons than any other yard in the country.

After a quiet first quarter, the New England **lumber** business enjoyed a good, though not soaring, market during the rest of 1952. Moderate slowness characterized the hardwood lumber market at mid-year and the softwood market in the third quarter. Both markets had strengthened substantially by late November.

Wood-furniture manufacturing got off to a strong start during the early months of 1952, slackened slightly in midsummer, and then had a somewhat better fall season than it did in 1951. Retail furniture sales showed no signs of retreating from established high levels as the year-end approached. Prospects for the coming months appeared favorable.

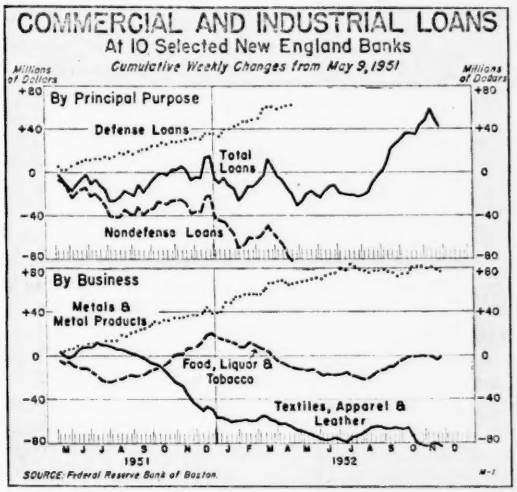
Nondurable-Goods Industries

Slow business in the textile industry held down employment in the nondurable-goods category until the fall pickup. By October, expanded employment in the rubber, shoe, textile and miscellaneous industries had brought employment in the nondurable-goods category almost to 1951 levels.

Textile-mill activity in New England improved gradually after the low point of the year in May. Employment in the mills expanded rapidly during the early fall as demand picked up in both the cotton-rayon and woolen-worsted segments of the industry. Textile-mill employment will probably continue below that of 1951, however, because several mills closed or moved during the year. The outlook for woolens was fairly good, while worsted mills continued to be in the least favorable position within the industry. Their activities were adversely influenced by imported fabrics and competitive synthetics.

Reduced retail inventories brought a volume of orders for summer and fall merchandise that kept New England **garment shops** busy past the usual fall peak production period. Manufacturers of women's wear enjoyed an especially good season, but some men's wear lines lagged.

As New England **shoe plants** completed runs of fall and winter shoes, both production and employment were well above the levels of a year ago. During the first nine months of 1952, New England output was nine per cent ahead of that in the same period in 1951. National output was about five per cent ahead. Except for production of men's shoes, which has been adversely affected by fewer government orders, output of all types of footwear in New England is well ahead of production in 1951. While part-time operations were prevalent by mid-November, the trade expected the between-season lull to be less severe than in most recent years.



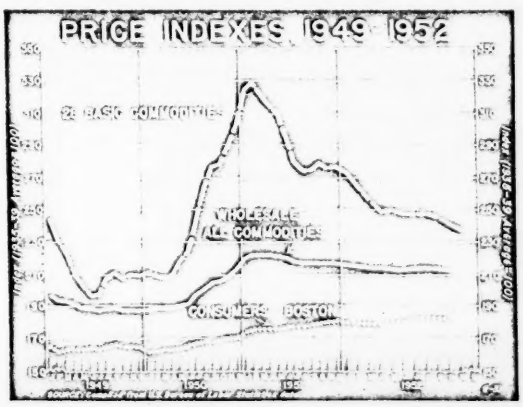
Costume-jewelry manufacturers in New England enjoyed the best Christmas business in several years. Reduced inventories, easier material supplies, and prospects for large holiday sales were reflected in peak levels of operations.

A break in the inventory log-jam resulted in a quickened tempo of activity in New England **rubber plants** during the fall months. Workers were recalled and the workweek lengthened. By September, employment was back to the level of a year ago. The pickup was principally in civilian lines, led by seasonal expansion in production of rubber footwear.

While seasonal expansion boosted the level of activity of some segments of the **printing and publishing** industry in the last quarter, the over-all pickup was not as great as a year ago. A good backlog of orders permitted greeting-card plants to continue adding workers through October in some areas.

Starting the year amid strongly competitive forces, the **pulp and paper** market sagged progressively until mid-August. By late November signs of betterment and increasing strength had appeared in the paper and paperboard markets. Most wood pulps, on the contrary, were suffering downgrading because more than ample supplies were coming on the market.

Activity in the region's **chemical** industry held very steadily at levels slightly below those of 1951. Prospects for increased employment arose out of scheduled expansion of chemical-plant facilities under government-approved certificates of necessity which reached a total of about $50 million by the year's end.



Monthly Review
FEDERAL RESERVE BANK OF BOSTON

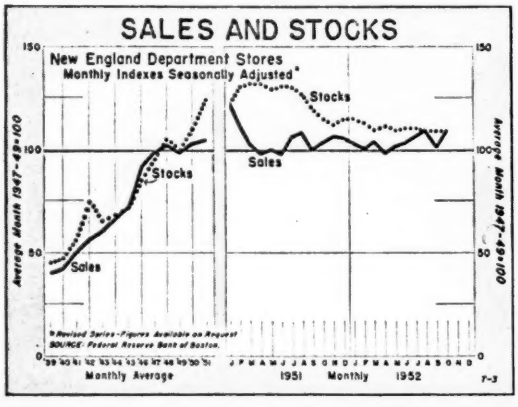
Shrewd Spending and Thrifty Saving 1952

NEW ENGLAND consumers in early 1952 somewhat resembled the proverbial ground hog who rouses from his winter sleep to look at the weather, sees his shadow and retreats into his burrow to doze until spring. At the beginning of 1952, the average consumer bought cautiously, after the buying sprees touched off by the Korean War, and stored up savings for the future.

In the spring and summer months, the removal of consumer credit restrictions and the continued easing of soft-goods prices brought a loosening of the consumer's purse strings at retail counters. He surveyed the varied assortment of merchandise with awakened interest and began to spend more freely, but with a discerning eye for goods which gave him the most value for his money. His appetite for spending quickened with the cooler weather of fall. Merchants vied for his dollars with special promotions and longer store hours for his shopping convenience. At the beginning of the Christmas shopping season his spending was running at somewhat lower levels than a year ago. Retailers hoped that last-minute shopping would boost Christmas sales above those of last year.

Comparisons of consumer purchasing in 1952 with that in 1951 have been affected by the high level of spending early in 1951. New England department and apparel stores began this year with dollar sales 17 per cent less in January than in the corresponding month of last year, 4 per cent less in February, and 10 per cent less in March. Several subsequent months of sales above those of last year raised the cumulative total of sales through October about even with corresponding sales a year ago. In November, however, department store sales fell behind last year's. Only substantial sales gains in the final weeks of Christmas shopping would lift sales for the year 1952 above those of 1951.

Consumer spending at department stores caught up to last year's levels more quickly in some New England states than in others. New Hampshire and Vermont stores passed the turning point in June. Sales of Maine stores caught up to last year's in September, and those of Connecticut stores followed in October. Massachusetts and Rhode Island sales trailed last year's sales by less than one per cent at the end of October.



Beginning in April, consumer buying at department stores in the larger New England cities showed general month-by-month improvement over that in the corresponding months of last year. Store sales in textile manufacturing centers such as Lowell, Lawrence, New Bedford and Providence responded to increased mill activity. Of the textile centers, the Lowell-Lawrence area, where sales had slipped the farthest during 1951, made the largest percentage recovery. Cumulative ten-month sales in that area were more than three per cent higher than in the same period last year. In most durable-goods centers, retail sales had climbed above the levels of a year ago at the end of ten months. New Haven and Springfield led the parade with year-to-year gains in department store sales of well over three per cent by the end of October.

Spending in downtown Boston department stores fell below 1951 levels during the summer months, but in Boston's suburban communities consumer purchases showed consistent year-to-year gains. Early in September the Boston stores, following the trend in several other large cities, added a second night opening to their weekly schedules. The immediate results seemed favorable for the downtown stores, as weekly sales began to push above sales in the corresponding weeks of last year. However, the strong surge in consumer buying in general made it difficult to assess the value to the Boston stores of the additional night shopping hours.

Basement Sales Increase

The New England consumer continued to be price conscious in his shopping during 1952. Of the various store departments, *basement* sales showed the largest net gain for the January to October period this year in comparison with sales for the corresponding period of 1951. The cumulative ten-month total was more than one per cent higher than a year ago.

In the principal main store departments, January to October sales of *women's and misses' ready-to-wear accessories* exceeded those for the same period last year by 0.4 per cent. The *women's and misses' ready-to-wear apparel* departments showed ten-month sales only slightly below those of last year.

Homefurnishings sales in department stores through the end of October were down almost seven per cent from similar sales last year. However, sales of a sample of New England retail furniture stores for the same period were two per cent higher than they were a year ago. In department store homefurnishings, major household appliances scored the best gains during the ten-month period. Sales of most other homefurnishing items jumped to levels higher than a year ago in May but subsided quite generally in the summer.

The removal of Regulation W controls on credit

terms stimulated a quick rise in instalment sales of department stores in May and lifted retail sales of most durable goods out of the doldrums of earlier months. In subsequent months instalment sales continued to exceed those of the corresponding months last year, but by lesser amounts as the first rush of pent-up demand for high-priced merchandise subsided. At the end of October, department store instalment accounts outstanding were 18 per cent higher than at the same time last year.

The stimulus of relaxed credit terms was not sufficient to lift new car sales in Massachusetts to last year's levels. Registrations of new automobiles in Massachusetts during May were nine per cent below those of a year ago and fell off to levels 12 per cent below last year's in June, 30 per cent in July, and 56 per cent in August as the steel strike cut into the supply of new cars available. Not till October, for the first time in sixteen months, did new car sales in Massachusetts exceed those of the same month in the previous year.

Stocks of merchandise stood at high levels in comparison with sales at New England department stores in early 1952. Stores held back on the ordering of new merchandise and whittled down inventories by special sales promotions and by moving surpluses into basement sales departments. By midsummer, total stocks were 16 per cent below their year-ago level and about in balance with sales performance. Store buyers began to order more freely in July in response to the strengthening in consumer spending. Rising consumer purchases, delayed ordering and slowed receipts of merchandise kept store stocks in close relationship to sales.

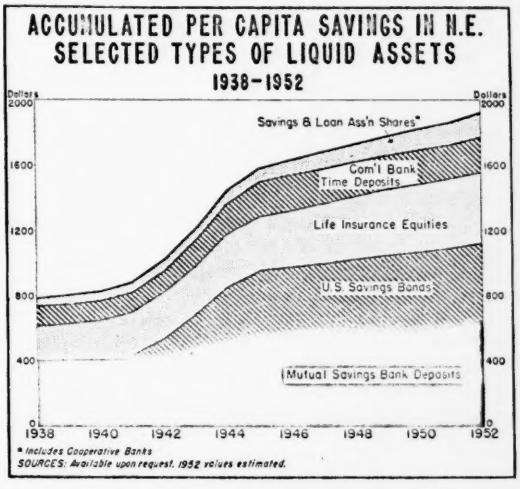
Liquid Savings Rise

High dollar incomes permitted New Englanders to build up their liquid savings while they maintained their consumer buying during 1952. A sizable $633 million was added to savings in the five forms shown in an accompanying chart. At the year's end, liquid savings in New England were about $18,024 million.

In per capita terms the growth is equally impressive. Using figures covering ten months of the year, estimates of year-end liquid savings for 1952 were compiled for New England and the United States. By the end of 1952, the per capita liquid savings of New Englanders in selected major categories were about $1,925, compared with $1,858 in 1951. Comparable per capita savings for the United States as a whole were $1,237 in 1951 and estimated at $1,283 by the end of 1952. For three years the rates of growth in per capita savings in the region and nation have been nearly identical.

The relative importance of the various components of liquid savings has not changed markedly. Mutual savings bank deposits remained the most popular form of personal savings in New England, accounting for about a third of all liquid savings. They are the only savings category which is relatively more important in New England than in the country as a whole. Per capita holdings in New England reached $609 in 1951 and are estimated to be $640 at the end of 1952. In comparison, per capita holdings in mutual savings banks in the United States were only $136 in 1951. They rose to an estimated $145 by the end of 1952.

United States savings bonds represented the second largest form of New Englanders' accumulated liquid savings in 1952. Although Series E bond sales increased slightly, redemptions rose even faster in 1952. Redemptions for other series did not change markedly in 1952, but sales dipped. In the United States as a whole, per capita holdings of savings bonds were an estimated $373 at the end of 1952, compared with an estimated $476 for New England.



Life insurance equities rose in value by almost $39 million during 1952. Per capita equities were about $438 at the end of the year, compared with $432 in 1951. New England per capita holdings were well ahead of those in the United States as a whole, where the per capita figure at the end of 1952 was about $394.

Time deposits in commercial banks have never been as important in New England as in the rest of the country because of the large number of mutual savings and cooperative banks in the region. During 1951, time deposits in New England registered a gain of $30 million, however, and the rise in 1952 was about $38 million. These two increases reversed a three-year period of declining time deposits. Per capita holdings in New England were estimated at $209 as 1952 ended.

Mutual savings banks registered the largest per capita dollar gain, but savings and loan associations and cooperative banks chalked up the fastest rate of growth during 1952. Early in 1952 the dollar volume of new-share purchases in Federal savings and loan associations was about 15 per cent higher than its volume in 1951. After midsummer the growth slowed down to a year-long rate of 12 per cent. In comparison, the year-to-year growth was six per cent in the volume of holdings at mutual savings banks in the region.

In retrospect, it appears that New England consumers acted with moderation during 1952. Their higher dollar incomes permitted them to pay higher taxes and still accumulate nearly $100 million more liquid savings, in the selected forms, than in the previous year. They saw no need for panic buying, but by persistence at the retail counters they held their buying at near-record levels. Slowly rising consumer prices and higher taxes absorbed some consumer purchasing power but still left physical consumption at high levels.

Monthly Review
FEDERAL RESERVE BANK OF BOSTON

Industrial Opportunities in New England:
LIGHT METALS

ONE OF THE outstanding developments of the past fifty years has been the emergence from obscurity of a group of metals which, prior to the turn of the century, were scientific curiosities. Some of these metals, particularly aluminum and magnesium, have long since achieved commercial production. Others, such as titanium and zirconium, have become more familiar names but are still produced in relatively small quantities. Development work on their extraction and the metallurgical properties of their alloys is still proceeding.

Historically, our major metals have been iron and steel. In recent years, however, the light metals — aluminum, magnesium, titanium, zirconium, and beryllium — have greatly increased in importance. It should be possible for New England to participate in the future growth of each of these industries. In some cases, New England may be able to produce the primary metal. In others, existing facilities elsewhere and particular requirements for those industries may preclude New England as a primary-metal-producing area, but they may not rule out the possibility of more extensive fabrication facilities in the region.

Aluminum

Of the various modern metals now in production or under experimental consideration, aluminum has experienced the most remarkable expansion. When facilities now under construction in the United States are completed in 1953, the industry will be approximately five times larger than it was in 1941 and about fifteen times greater than it was in 1931.

While a high percentage of this production is currently going to military applications, some well-informed sources feel that civilian demands will be such that when current military plans are completed, the civilian markets will be adequate to absorb the quantities released by the military and still leave a deficit in capacity for the future.

While the total Canadian capacity is not as great as that of the United States, it too has been increased. The largest single aluminum reduction plant in the world, with an annual capacity of 363,000 tons, is located at Arvida, Quebec. Other aluminum reduction facilities located in Quebec bring the total Canadian capacity up to 520,000 tons a year.

Several factors have contributed to the phenomenal growth of the aluminum industry. Wartime needs overpowered natural inertia in developing new fabricating techniques. A falling or stable price record encouraged new uses of aluminum in the electrical equipment, automobile, and construction industries. Impetus from these developments has set the stage for further growth.

The basic raw material for aluminum production is bauxite. Although extensive domestic deposits of bauxite exist and form a partial source of supply, higher grade deposits are located outside the country in such places as British Guiana and Jamaica. These deposits constitute the principal sources of bauxite for the three present producers of aluminum in the United States and the one Canadian producer. Since bauxite is necessarily shipped by water, this has resulted in a tendency to locate plants for the separation of alumina from bauxite near navigable water. Such alumina plants are in many cases not contiguous to the aluminum reduction plants where the alumina is reduced to metallic aluminum in ingot form.

Recent expansions in the alumina separation facilities of the various United States producers have been adequate to serve the requirements of their reduction plants. Consideration might be given, however, to the feasibility of utilizing New England ports for the establishment of alumina separation facilities to serve the requirements of such reduction plants as those of the Aluminum Company of America at St. Lawrence and Massena, New York. In order to make firm projections it would be necessary to determine the adequacy of existing supplies to these reduction facilities and the alternative cost of supplying them from other sources.

In the production of alumina, the raw material bauxite is the largest cost factor. Fuel and labor are the next most important cost items. Fuel costs in the New England area in comparison with those in other areas would, therefore, be of considerable importance in the detailed cost comparisons necessary to establish the feasibility of a New England alumina separation plant.

In the reduction of alumina to aluminum metal, alumina and other raw materials are the most important cost items. Next, and of major importance, is electric power. To be economically competitive, most reduction plants are located close to sources of cheap power. This factor precludes consideration of New England as an area for an aluminum reduction plant unless future power development should provide for power rates substantially under those now existing.

Before useful articles can be manufactured from metallic aluminum, the metal must be fabricated into standard forms such as sheets, rods, bars and other shapes, or castings. The three United States producers of the metal also maintain fabrication facilities. The combined capacity of the fabrication plants, in pounds of metal, is greater than primary metal capacity in order to provide for fabrication from scrap and imported ingots. Also, there are fabrication facilities which are independent of the primary metal producers.

This article is the fifth in a series of abstracts from the Arthur D. Little, Inc., study of Industrial Opportunities in New England. A reproduction of the complete study may be obtained for $2.00 on request to the Research and Statistics Department, Federal Reserve Bank of Boston, 30 Pearl Street, Boston 6, Massachusetts.

Aluminum fabrication plants are scattered. In only a few instances are they contiguous to reduction plants. Consideration should be given to the possibility of transporting aluminum ingots via water from Texas or from Alcoa or Aluminum, Ltd., plants to the New England coast for fabrication into primary shapes in a new fabrication plant.

Some southern New England plants in the brass and copper industries are fabricating aluminum in a limited number of forms. In addition, there are moderate-size New England plants for making aluminum sheet and foil. A new aluminum facility might well be profitable if it produced larger products and a wider variety of shapes, rather than being an adjunct to the brass and copper industry. The large fabrication plants nearest New England at present are Alcoa's facilities at Massena, New York; Edgewater, New Jersey, and Cressona, Pennsylvania.

In contrast to the domestic situation where the capacity for primary metal is less than that of fabrication facilities, Aluminum, Ltd., of Canada has a fabrication capacity which is only 27 per cent of its current ingot capacity and 20 per cent of its potential capacity when expansion plans are completed. This provides an obvious source of metal supply for an independent fabricator located in New England. While an import tariff of $30 per ton is imposed on Canadian-produced metal brought into this country, Canadian costs are low enough for successful competition in American markets.

Magnesium

Magnesium, the lightest of the structural metals, is in a stage of development comparable to that of aluminum about ten years ago. Primary metal production rose from approximately 3,300 tons in 1939 to a peak of 183,600 tons in 1943. After the war enormous stocks of scrap and government surplus came on the market and production declined to approximately 5,200 tons by 1947. In 1949, primary metal production was 11,500 tons. Accelerated by military demand, it increased to 38,500 tons in 1951. It is anticipated that by early 1953 capacity in private plants will have increased to 29,500 tons and in reactivated government plants to 102,000 tons. Although the primary applications of magnesium to date have been military, there has been a steady, if unspectacular, increase in civilian demand.

Unlike aluminum, the basic raw material for reduction to magnesium is derived from sea water. Other sources of raw materials are certain brines and dolomitic limestone. The domestic sources of raw materials are, therefore, virtually inexhaustible.

The only private domestic electrolytic producer of magnesium is Dow Chemical Company. Several other companies operated electrolytic plants for the government during the war. Of these, the plant operated by Diamond Alkali Company has been reactivated.

Other magnesium plants utilizing thermal reduction processes were constructed during World War II, but they have not been economically competitive with plants using the electrolytic processes.

As with aluminum, power is an extremely important cost factor in the production of magnesium. New England does not appear to be a promising area for a reduction plant, unless means can be found to provide lower power rates than now exist. Again, however, because of the possibility of water transportation, New England might be given consideration as a site for a fabrication plant which would import magnesium ingots from Freeport, Texas, via water.

Titanium

Titanium, the ninth most abundant element in the earth's crust, is not a "new" metal. It is the fourth most abundant structural metal, exceeded in this respect only by aluminum, iron, and magnesium. It was discovered in 1790, and it received its mythological name in 1795. Successful attempts to produce the pure metal date back to 1887, and in 1910 titanium of over 99 per cent purity was produced.

The metal came into its own only recently, however, primarily due to improvements in the economics of production, but secondarily because of its ability to satisfy many of the demands of present-day technology. The most prominent new source of raw materials in this hemisphere are the Sorel, Quebec, deposits being worked by Quebec Iron & Titanium Corporation.

Titanium metal, in the eyes of many metallurgists, has potential applications equal to those of stainless steel. It will probably develop in this direction, rather than compete with some of the lighter metals such as aluminum and magnesium. On an equal strength basis, its weight is less than that of aluminum or stainless steel. Its qualities of corrosion resistance and potential surface hardness are outstanding. The current high price of the metal ($5.00 a pound for sponge, up to $14.00 in shapes) has precluded many commercial applications which will come into being as soon as its price is reduced. Currently, only those applications which require the particular characteristics of the metal can justify the high cost, and such applications are mostly of a military nature.

Titanium ore is available on the open market at less than $0.05 a pound. Recovery of the pure titanium metal from its oxide and the formation of this metal into massive forms suitable for subsequent fabrication present some problems not previously encountered with any other structural metals. For titanium to be useful as a structural material, it must be in a ductile form which will permit it to be worked into shape. Its ductility is destroyed if contaminants such as oxygen, nitrogen and carbon are permitted to react with the metal. The raw material used in the production of the metal must be of high purity, therefore, and extreme care must be taken during production to exclude possible contaminants. The methods now in use for the extraction of titanium from its ores are all batch processes. Large research expenditures are being made by several companies, as well as government agencies, on other processes which would be more amenable to large-scale and continuous operation. Most of this research is being done on electrolytic processes such as are used for the production of aluminum and magnesium.

The Kroll process for reduction of titanium in batches was first announced by the United States Bureau of Mines late in 1946. That agency is said to have spent some $10 million over a five-year period in developing the process. In the Kroll process, magnesium is heated to about 300° F in the presence of helium in an iron

reduction pot or "bomb," which is provided with a tight cover. The temperature is increased to about 1,400° F and maintained at that point while titanium tetrachloride is added. The reduced charge is cooled, and most of the resulting magnesium chloride is tapped off as a liquid. The remainder is distilled under vacuum. The metal is then removed in the form of sponge.

The feasibility of New England as an area for the primary production of metal necessarily depends on the ultimate commercial process utilized. Among the various cost factors of the Kroll process, raw materials and labor are the most prominent. Power, while an important cost factor, is secondary in comparison with labor and raw materials and does not materially influence the ultimate cost of the metal. This assumes importation of magnesium from some other area, since production of magnesium in an integrated plant would require low-cost power. Considering the Quebec Iron and Titanium Corporation operations at Sorel, Quebec, as a potential source of raw materials to be imported into New England via water, the possibility of New England as an area for a Kroll-process reduction plant would appear feasible. If present research efforts on electrolytic processes are successful, however, the relative importance of the above cost factors would be altered. In an electrolytic process, power and raw materials would become the most prominent items, while the cost of labor would diminish. The incentive would be strong to locate electrolytic reduction plants as close as possible to sources of low-cost power.

The formation of titanium sponge into ingots for rolling into sheet or forging into bars may also be carried out in several ways. If the Kroll process continues in use, further development work will be necessary to achieve the most economical means of compacting the sponge into a form which is susceptible to fabrication. The ideal electrolytic process would produce a dense, coherent mass which, with minor additional treatment, could be used in fabrication. However, published information indicates that the metal from electrolysis is in a finely divided state which also requires some method of consolidation before it may be readily fabricated. Fabrication of titanium metal or its alloys is in many respects similar to the handling of alloy steels and presents no really unusual problems.

In the absence of any clear indication with respect to a reduction plant and in view of the fact that no really large plants for the production of the metal have been established, one may not at this time even speculate on the position of the New England area as a location for facilities for production of primary shapes. Should the Quebec development integrate to the point where the slag now being produced there is utilized at the same location for the production of metal, the possibility of shipping the metal by water from Quebec into the New England area for rolling and production of primary shapes should be given detailed consideration.

Zirconium

Zirconium belongs to the same family of metals as titanium but differs in the corrosion resistance and structural properties. It is more resistant to corrosion than titanium but has a less favorable strength-weight ratio. Zirconium, therefore, will probably not be considered for structural uses where strength and lightness are primary requisities, but it will be favored in such applications as chemical equipment where resistance to corrosion is of greatest importance.

The current primary source of the raw materials is in Florida sands and in ores located in the Midwest and in California. Comments made in the preceding section on titanium with respect to processes are equally applicable to zirconium. With regard to raw materials, the zirconium concentrates might be barged by water from Florida to the New England area for reduction to the metal. The appropriateness of such a development would depend on continued use of the Kroll process.

Present production of zirconium is on a comparatively small scale. It is used in a powder form for special applications, chiefly in the vacuum tube field. So far as is known, no company is producing the metal in the form of shapes for further fabrication. The U. S. Bureau of Mines operates the largest reduction facility in this country at Albany, Oregon. It is understood that the production from this plant is directed principally to the Atomic Energy Commission.

Beryllium

The only reason for considering beryllium in this review is the local availability of raw materials. While most of the beryllium ore consumed in this country is imported, principally from Brazil, beryl has been produced sporadically in most of the New England states. Production figures showing the amounts produced from the various states are not available but would total less than 100 tons per year. This compares with imports of approximately 3,800 tons in 1949.

Beryllium is a hard, non-malleable metal slightly heavier than magnesium. The commercial uses of the unalloyed metal are few and are confined to miscellaneous applications such as windows in X-ray tubes and electrodes and targets in some types of vacuum tubes.

The Atomic Energy Commission is investigating the usefulness of beryllium metal in power reactors. It is impossible to estimate the ultimate possible consumption of beryllium in this application since it is only one of several materials being investigated for this purpose. In any case, its use would be dependent upon the many variables affecting the future of atomic power.

The major use of beryllium at present is in the fabrication of copper alloys containing approximately two per cent beryllium. Although these alloys possess no unique physical characteristic, their combined physical properties make them useful in a number of special applications such as current-carrying springs.

The most prominent cost item in the production of beryllium materials is the beryllium ore. Since the production of beryllium and its alloys is carried out in an electric furnace, power is an important cost item. In this respect, under existing conditions New England would be at a disadvantage in contrast to other locations in the country having lower-cost power. Future power developments in this area, however, combined with any future price increases for foreign ore or a demand which exceeds foreign supplies might make it possible to establish an integrated operation in New England for the mining, concentration, and reduction of beryl to produce beryllium and beryllium alloys.